Department of Energy

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Office of Energy Efficiency and Renewable Energy
Office of Transportation Technologies
U.S. Department of Energy
1000 Independence Avenue, SW
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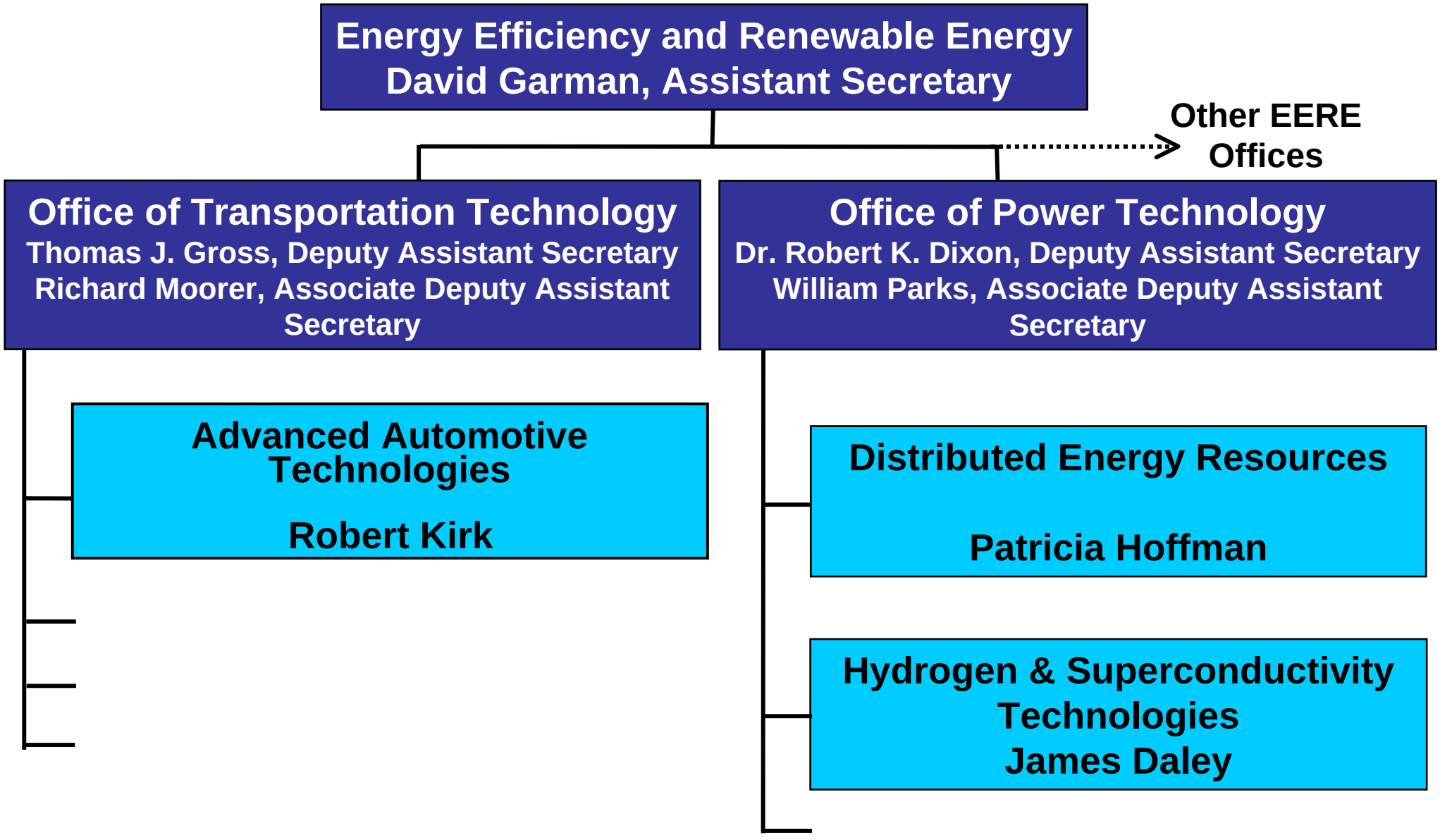
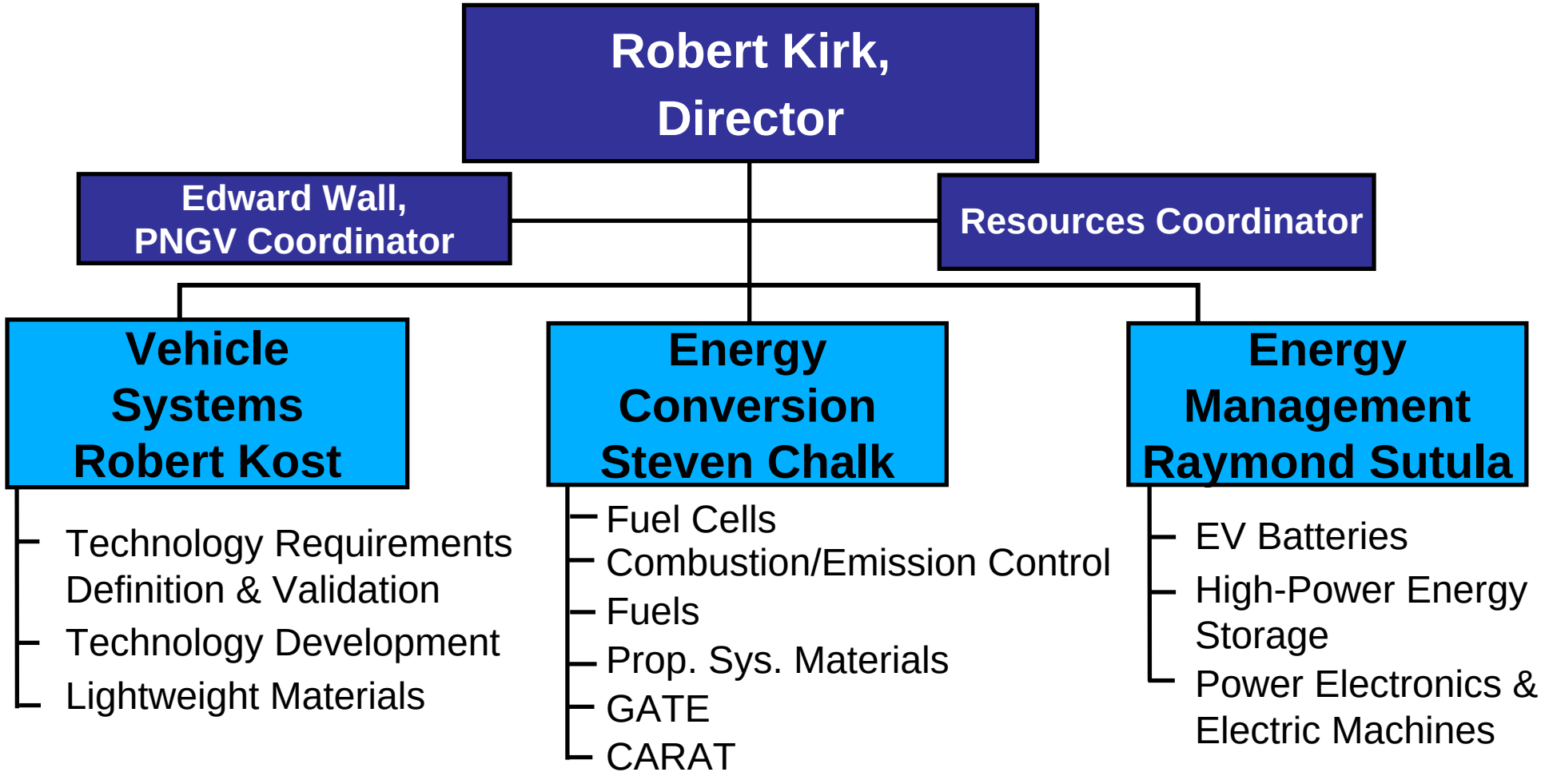
Kick-Off Meeting for
Cooperative Agreements Awarded Under
Solicitation DE-RP04-01AL67057
October 30, 2001
U.S. Department of Energy
Washington, D.C.

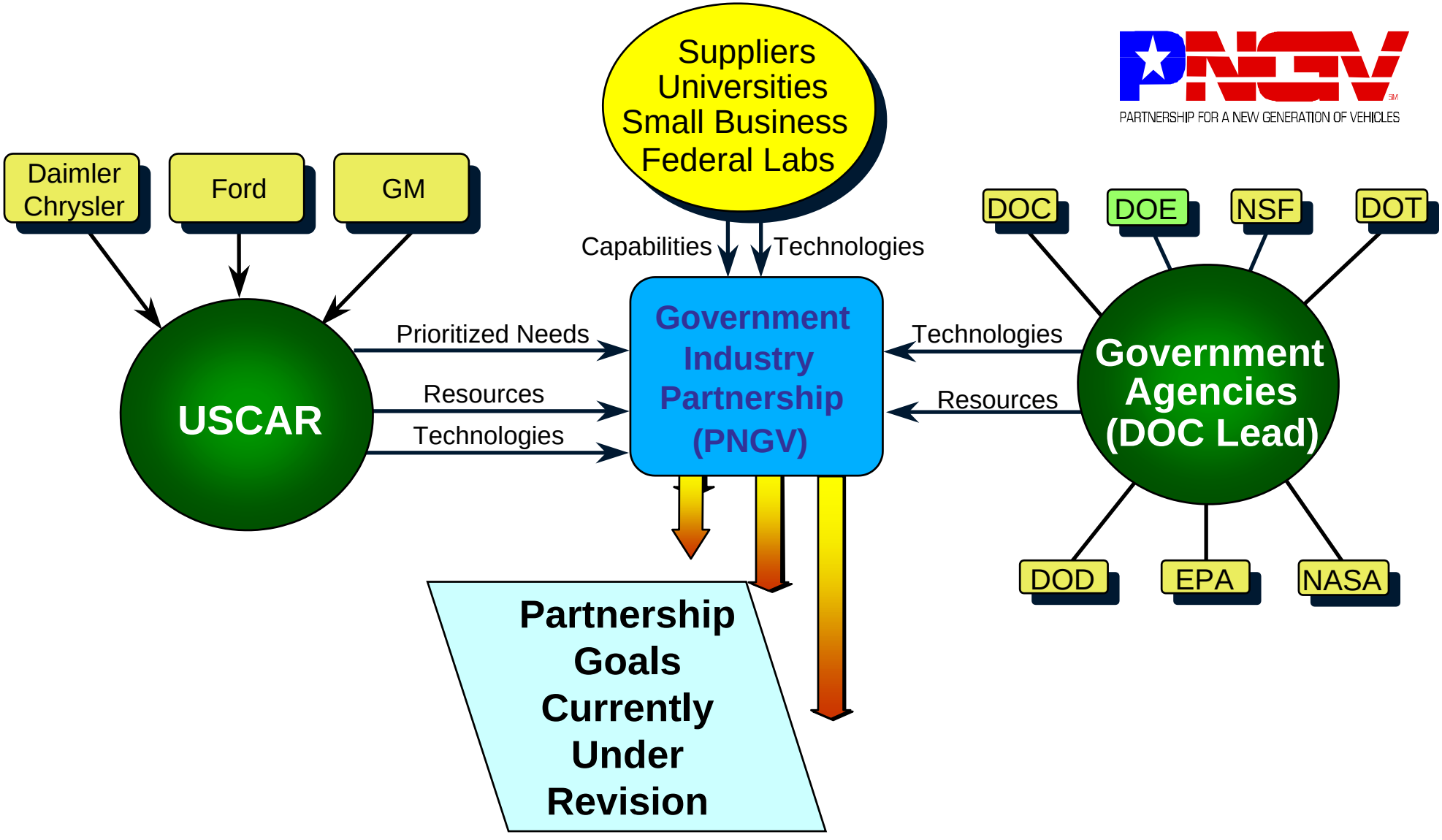
Energy Efficiency Organization



Office of Advanced Automotive Technologies: Organization

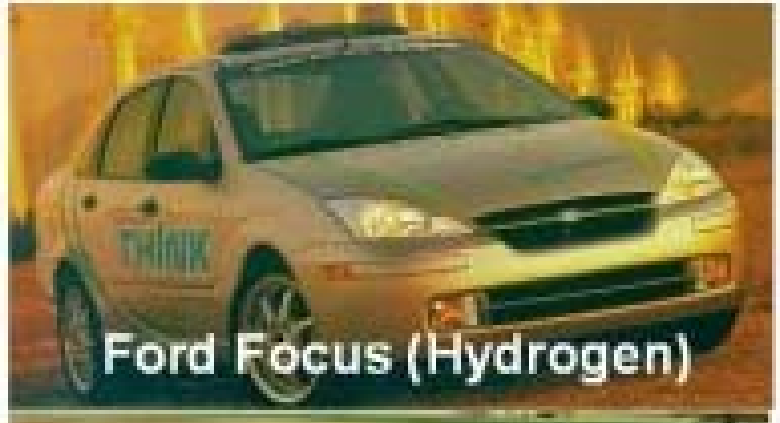


PNGV: A Historic Collaboration Between Industry & Government

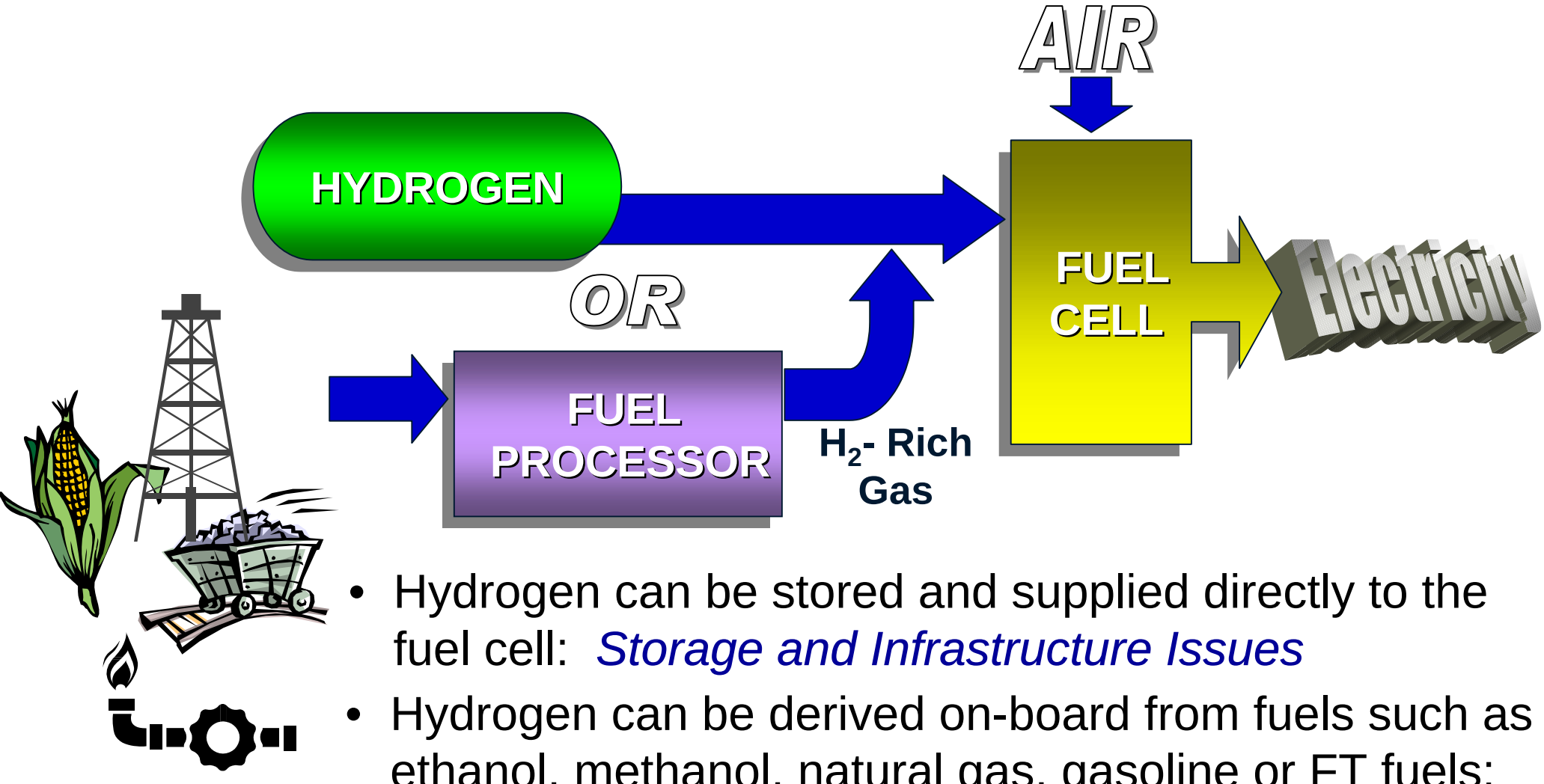


Fuel Cells for Transportation

Our goal is to develop highly efficient, low- or zero-emission cost-competitive automotive fuel cell power system technologies that operate on conventional and alternative fuels



Dual Path Transportation Fuel Cell
Fuel Strategy



- Hydrogen can be stored and supplied directly to the fuel cell: *Storage and Infrastructure Issues*
- Hydrogen can be derived on-board from fuels such as ethanol, methanol, natural gas, gasoline or FT fuels: *Complexity, Cost, and Start-up Issues*

Revised Technical Targets
Integrated Fuel Cell Power Systems*
Gasoline Fueled

Characteristics	Units	Status	Calendar year 2004	2008
Energy Efficiency @ 25% of peak power	**%**	**34**	**40**	**44**
Energy Efficiency @ peak power	**%**	**31**	**33**	**35**
Power Density	**W/L**	**140**	**250**	**325**
Specific Power	**W/kg**	**140**	**250**	**325**
Cost	**$/kW**	**300**	**125**	**45**
Transient Response (10 to 90% power)	**sec**	15	5	1
Cold Startup (-20°C to Max Power)	**min**	**10**	**2**	**1**
Cold Startup (20°C to Max Power)	**min**	**<5**	<1	<0.5
Survivability	**°C**	**-20**	**-30**	**-40**
Emissions	**<Tier 2Bin2**	**<Tier 2Bin2**	**<Tier 2Bin2**	
Durability	**hours**	**1000**	**4000**	**5000**

- Timeframe extended to 2008
- Efficiency target relaxed (supported by system analysis
- Some targets more stringent (W/L, W/kg, Cost)
- Survivability targets added
- Defined durability targets

**** Includes fuel processor, stack, auxiliaries & start-up devices; excludes gasoline tank & vehicle traction electronics; all watts are W_e***

Revised Technical Targets
Fuel Cell Stack Sub-Systems

Running on Hydrogen-Rich Fuel from Fuel-flexible Fuel Processor – 50kW Peak Power (continuous)
Includes fuel cell ancillaries: heat, water & air management systems - excludes fuel processing/ delivery system

Characteristic	Unit	Status	Calendar Year 2004	2008
Stack System Power Density	W/L	200	400	550
Specific Power	W/kg	200	400	550
Efficiency @ 25% of peak power	%	45	50	55
Efficiency @ peak power	%	40	42	44
Precious Metal Loading	g/peak kW	2.0	0.6	0.2
Cost	$/kW	200	100	35
Durability	hours	>1000	>4000	>5000
Transient Response (from 10 to 90% power)	sec	3	2	1
Cold Startup @ -20°C to Maximum Power	min	2	1	0.5
Cold Startup @ 20°C to Maximum Power	min	1	0.5	0.25
Survivability	°C	-20	-30	-40
CO Tolerance (steady state-2%max air bleed)	ppm	25	500	500
CO Tolerance (transient)	ppm	100	500	1000

Note: All watts are W_e

Revised Technical Targets
Fuel-Flexible Fuel Processors

Includes controls, shift reactors, CO cleanup, heat exchangers - excludes fuel storage

Characteristic	Units	Status	Calendar Year 2004	Calendar Year 2008
Energy efficiency	%	78	78	80
Power density	W/L	500	700	800
Specific power	W/kg	450	700	800
Cost	$/kW	85	25	10
Cold Startup (-20°C to Max Power)	min	TBD	2	1
Cold Startup (20°C to Max Power)	min	<6	<1	<0.5
Transient response (10 to 90% power)	sec	15	5	1
Emissions		Tier2Bin2	Tier2Bin2	Tier2Bin2
Durability	hours	1000	4000	5000
Survivability	°C	-20	-30	-40
CO in product stream - steady state	ppm	10	10	10
CO in product stream - transient	ppm	500	100	100
H_2S in product stream	ppm	<0.3	<0.2	<0.1
NH_3 in product stream	ppm	<10	<5	<1

Note: All watts are W_e

Automotive Fuel Cells
Key Technical Challenges

There are significant technical and economic barriers that will keep fuel cell vehicles from making significant market penetration for 10 years.

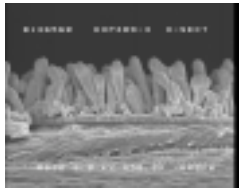
- Cost/Affordability (Platinum)
- Start-Up (Gasoline System)
- Durability
- Thermal/Water Management
  - heat rejection
- Air Management
- Hydrogen Storage/Refueling

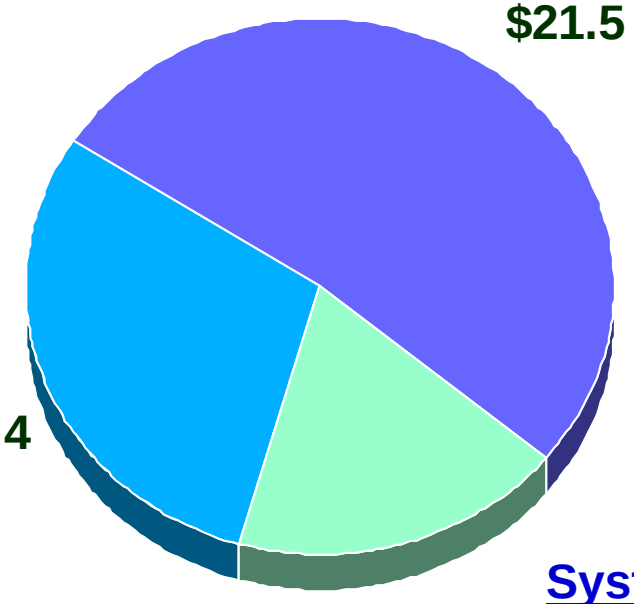
Program Addresses Technical Challenges through cost-shared R&D with industry and applied research at national labs and universities

Challenge	Current R&D Projects
Cost	ADL/DTI – Cost Analyses 3M, SWRI/Gore – High Volume, Low Pt MEA Fabrication GTI, ORNL – Bipolar Plates ANL, UMich, NexTech - Improved FP, WGS Catalysts LANL – Low Pt Electrodes
Durability	LANL, most projects are now addressing durability.
Air Management	Honeywell, Mechanology – Compressors
StartUp (Fuel Processing)	Nuvera- adsorbents, catalysts, heat exchangers ANL, UMich, NexTech - Improved FP, WGS Catalysts PNNL – Microchannel Fuel Processing
Thermal/Water Management	LANL/Universities – High temperature membranes ORNL – Carbon foams for radiators/humidification

Program Activities – Fuel Cells

FY 2001 Budget = $41.5M
FY 2002 Conference Mark = $41.925M





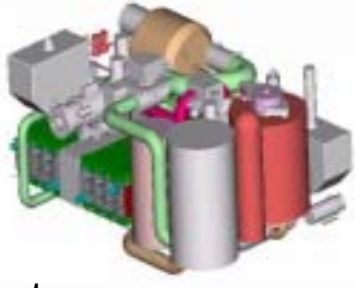
Fuel Processing/ Storage Subsystem

- Catalyst R&D
- Fuel Processor R&D
- Fuel Effects/Durability Studies
- Microchannel Components
- CO & Sulfur Management
- Hydrogen Storage R&D

Fuel Cell Stack Subsystem

- Catalyst R&D
- High Temperature Membrane R&D
- MEA/Bipolar Plate Manufacturing Processes
- Cost Reduction R&D
- Durability Studies
- Direct Methanol Fuel Cells

Systems



- System Validation
- System Modeling
- Ancillary Components (Compressors, Sensors)
- Cost Analyses
- Emissions Testing

DOE Fuel Cell R&D Program Trend – Less Focus on Systems/Subsystems, More Focus High Risk R&D/Critical Needs

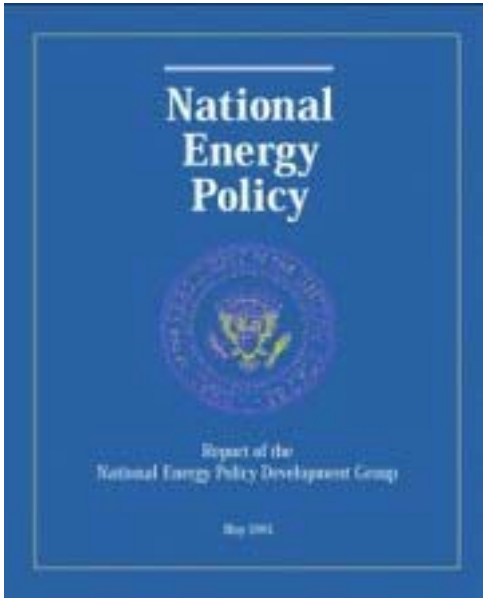
2001 Solicitation → $80M, 2-4 years, beginning FY2002

- **Fuel cell stack critical R&D**
  - high-temperature membranes → heat rejection, CO-tolerance
  - higher activity cathodes → efficiency
  - low-Pt MEAs → cost
  - bipolar plate/MEA processes → high-volume manufacture
- **Fuel processor materials/components**
  - R&D for fast, efficient response → start-up time, transients
  - water-gas shift catalysts → durability, cost, efficiency
  - compact reactors/heat exchange → efficiency, size, weight
- **Balance-of-plant components**
  - sensors/actuators → response time, durability
- **Hydrogen Storage/Refueling**
  - carbon-based/metal hydrides → storage capacity
  - refueling technologies → infrastructure

House/Senate Conference Remarks

H.R. 2217 "The Department should report to the House and Senate Committees on Appropriations, within twelve months of the date of enactment of this Act, on the technical and economic barriers to the use of fuel cells in transportation, portable power, stationary, and distributed generation applications. The report should include recommendations on program adjustments based on an assessment of the technical, economic, and infrastructure requirements needed for the commercial use of fuel cells for stationary and transportation applications by 2012. Within six months of the date of enactment of this Act, the Department should also provide an interim assessment that describes preliminary findings about the need for public and private cooperative programs to demonstrate the use of fuel cells in commercial scale applications."

Support of the Administration



- "Recommendation: …develop legislation to provide for a temporary income tax credit available for the purchase of new hybrid or fuel cell vehicles.
- "Recommendation: …to develop next generation technology, including hydrogen…

- President George W. Bush: "I'm pleased to announce $85.7 million in federal grants to encourage academia and the private sector to join with contributions from the [public] sector to accelerate the development of fuel cells, advanced engines, hydrogen technology and efficient appliances for American consumers."-June 28, 2001

For Further Information

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Office of Transportation Technologies: www.ott.doe.gov

PNGV: www.ta.doc.gov/pngv/cover/pngvcover.htm